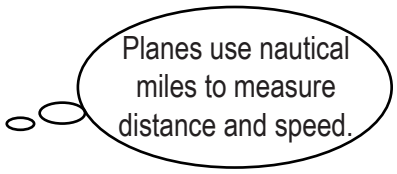
LineUp With Math™

Math-Based Decisions in Air Traffic Control

Student Workbook A

- **Introduction to Real Air Traffic Control**
  - **Units**
  - **Sector Display**
  - **Sector Information**
  - **Spacing Information**



Investigator: _____

An Airspace Systems Program Product

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Understand Units

Distance:

Travel on land is measured in Statute Miles - commonly called “miles”.

Travel in the air and on the sea is measured in **Nautical Miles (Nmiles)**.
A nautical mile is a little *longer* than a statute mile.

1 nautical mile = 1.15 statute miles

Speed:

Speed on land is measured in Miles per Hour (mph).

Speed in the air and on the sea is measured in Nautical Miles per Hour - commonly called “**knots**” **(Kts)**.

1 “knot” = 1 nautical mile per hour

Just as a Nautical Mile is a little *longer* than a Statute Mile, 1 Knot (nautical mile per hour) is a little *faster* than 1 mile per hour.

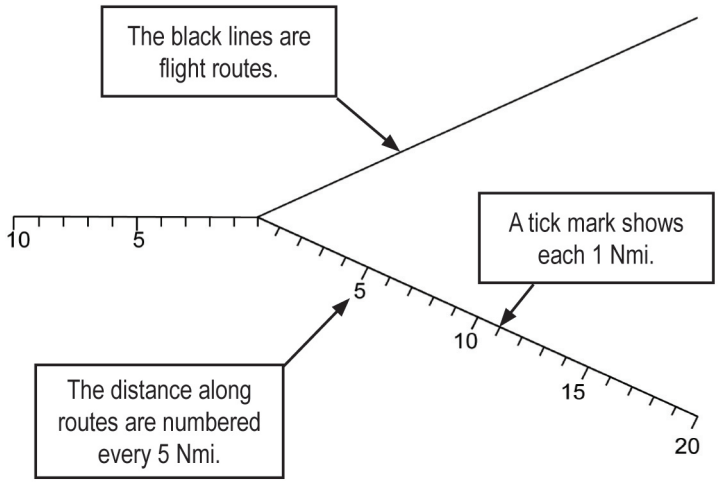
Understand the Sector Display

A **Sector** is the air space above a specific geographical section of the country.
Each sector has 2 air traffic controllers. They are responsible for the safe and efficient flight of all aircraft in that sector.

A sector is composed of many interconnected **Routes**. Routes are invisible pathways in the sky.

When you look at an air traffic problem display, you will see:

- Lines to show the routes
- Numbers at each 5 nautical mile distance
- Tick marks at each 1 nautical mile distance

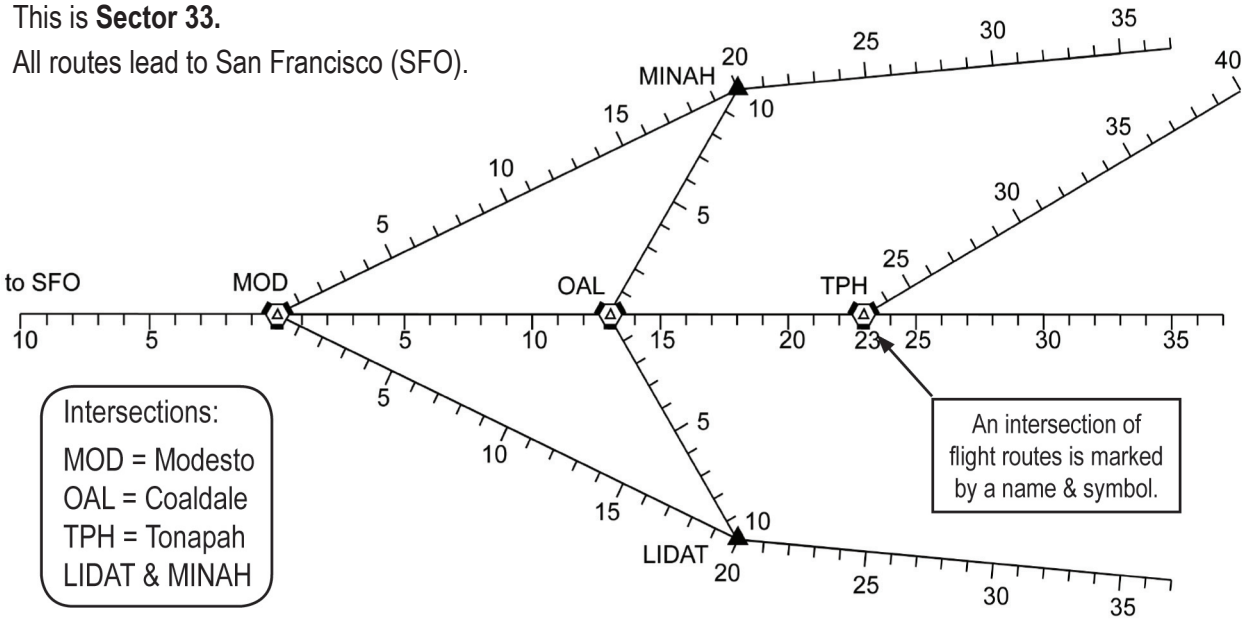


Continue to Next Page

Investigator: _____

Understand Sector Information (Continued)

- This is **Sector 33.**
- All routes lead to San Francisco (SFO).



- Sector 33 is a real sector in northern California. But we've used different distances.
- Sector 33 controllers merge traffic onto a single route at MOD.

It is important that you understand the distances between intersections.

1 Circle the intersections at MOD and MINAH.

2 What is the direct distance from:

	MINAH	TPH	LIDAT
To MOD?	____ Nmi	____ Nmi	____ Nmi
To OAL?	____ Nmi	____ Nmi	____ Nmi

3 How far is it from MINAH to OAL to MOD? _____ nautical miles

4 How far is it from MINAH to MOD directly? _____ nautical miles

5 How much shorter is it to go from MINAH to MOD directly rather than by way of OAL? _____ nautical miles

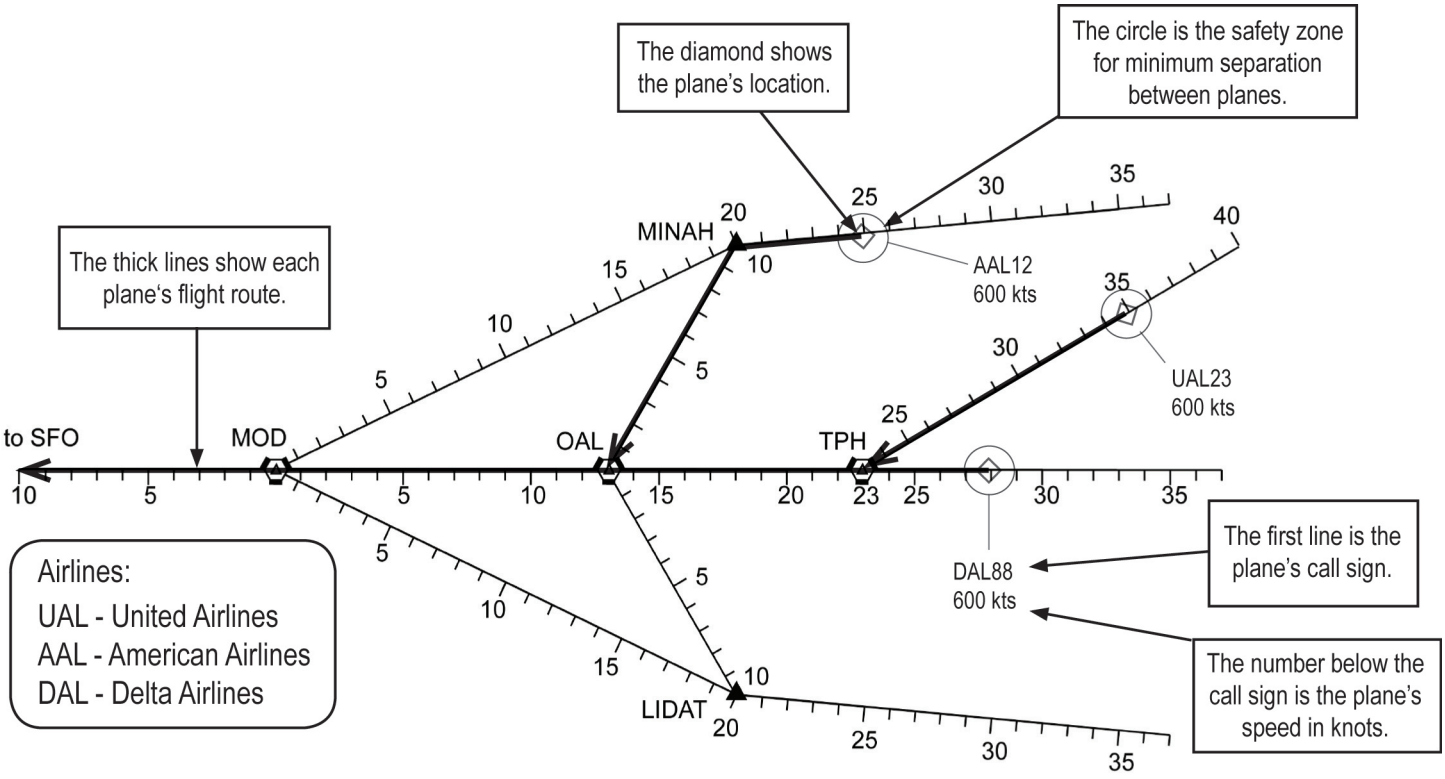
6 How much further is it to go from LIDAT to MOD by way of OAL rather than directly? _____ nautical miles

Continue to Next Page

Investigator: _____

Understand Sector Information (Continued)

- **Information for each plane**, including its position, is shown on the sector display.



7 Circle the diamond for the Delta Airlines flight on the sector display.

8 What is the speed of the Delta Airlines flight? _____ knots

A **Flight Plan** is a plane's route of travel from intersection to intersection, including speed (knots) and altitude. In our case, the altitude will be the same for all planes.

9 Locate flight AAL12 and write the intersections (in order) for its flight plan to San Francisco (SFO):

To: _____ Then to: _____ Then to: _____

10 What is the length of the flight route of AAL12 from its current position to MOD? _____ Nmiles

11 What is the length of the flight route of UAL23 from its current position to MOD? _____ Nmiles

End of Worksheet

Understand Airplane Spacing Requirements

Investigator: _____

The **Objective** of air traffic control is to ***safely*** and ***efficiently*** move planes to their destinations.

Safety - Minimum Separation

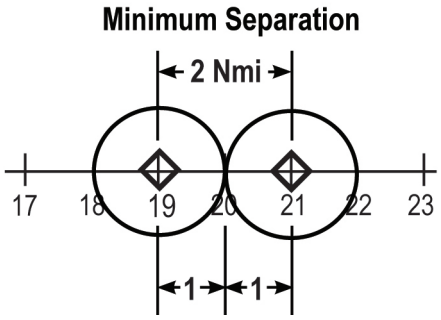
To be **safe**, planes must **always** be kept far enough apart that collisions and near-misses ***NEVER*** happen.

- The Federal Aviation Administration has established the least distance allowed between planes. This is called the **Minimum Separation**.

  You will use **Minimum Separation = 2 nautical miles**

- On air traffic control displays, this minimum separation is shown by a "safety circle" around the plane symbol. The circle radius is 1 nautical mile.

- When two circles just touch, the distance between the planes is 1 nautical mile + 1 nautical mile = 2 nautical miles, the minimum separation.



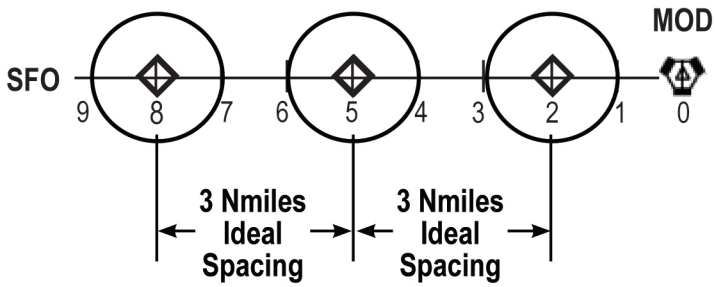
Efficiency - Ideal Spacing

- At SFO, planes arrive from Sector 33 and from other sectors.
  So, at MOD the Sector 33 controllers must leave more than 2 nautical miles to let planes from other sectors merge after MOD.

- This greater spacing is referred to as **Ideal Spacing.**

  Ideal Spacing at MOD = 3 nautical miles

- You must aim for Ideal Spacing at MOD.
  Everywhere else you need at least Minimum Separation.



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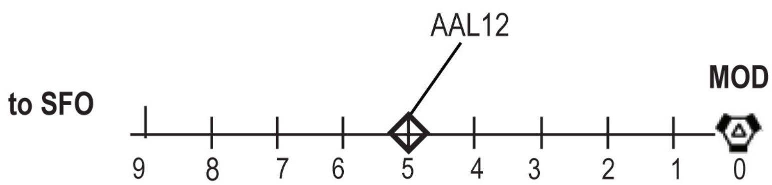
Investigator: ____________________

Understand Airplane Spacing Requirements (Continued)

1 What is the Minimum Separation requirement? ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 Nmiles

2 What is the Ideal Spacing? ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 Nmiles

3 On the plot below, AAL12 is flying from MOD to SFO. Using the Minimum Separation, draw a "safety circle" around the flight symbol for this flight.

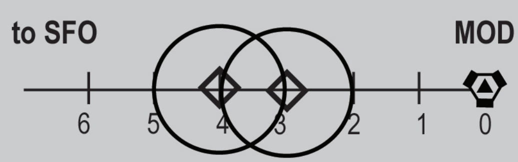


4 UAL74 is **following** AAL12 to SFO. On the route, draw a diamond to show UAL74 at the Minimum Separation.

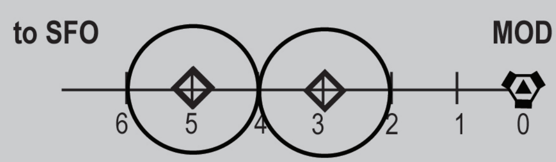
5 Draw a "safety circle" around the diamond for UAL74.

6 DAL88 is **ahead** of AAL12 to SFO. On the route, draw a diamond and a safety circle to show DAL88 at the Ideal Spacing.

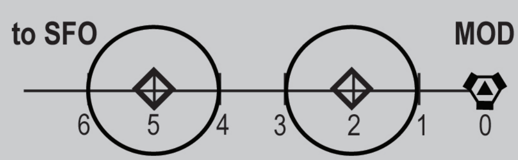
7 In each diagram, check all boxes that are **true**.



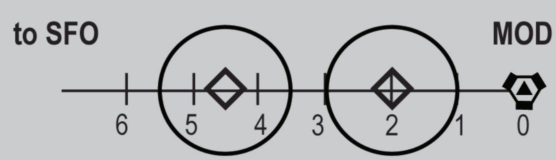
Safe? ☐ Yes ☐ No Ideal? ☐ Yes ☐ No



Safe? ☐ Yes ☐ No Ideal? ☐ Yes ☐ No



Safe? ☐ Yes ☐ No Ideal? ☐ Yes ☐ No



Safe? ☐ Yes ☐ No Ideal? ☐ Yes ☐ No

End of Worksheet